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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request f r filing a PROVISIONAL APPLICATION FOR PATENT und r 37 CFR 1.53(c).

INVENTOR(S)

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☐ *Additional inventors are being named on the____ separately numbered sheets attached hereto*

TITLE OF THE INVENTION (280 characters max)

A METHOD AND APPARATUS FOR OPTIMIZING DECODING TIMES AND VERIFICATION OF THOSE TIMES IN A PIPLINED GRAPHICS DECODER MODEL INCORPORATING AN IMAGE BUFFER AND GRAPHICS PLANE BUFFER

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ENCLOSED APPLICATION PARTS *(check all that apply)*

☒ Specification *Number of Pages* 26 ☐ CD(s), Number

☐ Drawing(s) *Number of Sheets* ☐ Other (specify)

☐ Application Data Sheet. See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT *(check one)*

EV336024537US

☐ A check or money order is enclosed to cover the filing fees

☒ The Director is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number 19-2814

☐ Payment by credit card. Form PTO-2038 is attached.

FILING FEE AMOUNT ($) $160.00

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: __________

Respectfully submitted,

SIGNATURE

Date 07.11.2003

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Docket Number: 17366.1450

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

A METHOD AND APPARATUS FOR OPTIMIZING DECODING TIMES AND VERIFICATION OF THOSE TIMES IN A PIPELINED GRAPHICS DECODER MODEL INCORPORATING AN IMAGE BUFFER AND GRAPHICS PLANE BUFFER

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention is directed to optimizing a pipeline decoder model applicable to a BD-ROM presentation graphics stream and more particularly is directed to increasing performance and providing rules to enable verification of data streams.

Description of Related Art

The ETSI EN 300 743 standard defines a conceptual decoder model and the syntax and semantics of a data stream to support Subtitling applications as part of the Digital Video Broadcast standard (DVB-SUB). This standard specifies the use of PES packets within an MPEG transport stream to carry the basis syntactic elements (Segments) of the Subtitling application. The PTS values of the PES packets are used to define the presentation time of each display update. No other timing information is provided to the decoder.

SUMMARY OF THE INVENTION

As part of the development of a BD-ROM format, the Blu-ray Disc Founders (BDF) are defining the syntax and semantics of data-streams and associated decoding models for presentation graphics (subtitles and other AV synchronized graphics) and interactive graphics (buttons – similar to the highlight functionality of DVD-Video). A DVD-SUB standard is being used as a base in these sections of the BD-ROM format.

The present invention, when applied to BD-ROM presentation and interactive graphics streams, provides advantages over the standard DVB-SUB model for decoder implementation and verification:

1. decoder performance: authoring can take advantage of the optimized pipeline decoder model to increase performance of decoding data.

2. verification: clear rules are provided to enable verification of data streams including data streams that take advantage of the optimized pipeline decoder model.

This innovation extends the DVB-SUB model to make use of DTS values to specify when the decoder should decode segment data stored in the Coded Data Buffer. This provides a framework for authoring a datastream to take advantage of a pipelined decoder model incorporating an image buffer and graphics plane buffer. Furthermore, this innovation provides a model that optimizes decoding within the pipeline framework and provides the rules necessary for verification of datastreams utilizing the optimized pipelined decoding.

The apparatus is comprised of the following:

1. The definition of DTS/PTS semantics for each Segment.

2. The definition of associative DTS/PTS rules for each Segment.

3. A decoding model supporting the use of DTS/PTS as specified.

BRIEF DESCRIPTION OF PREFERRED EMBODIMENT

Please refer to the attached document for a more detailed description of the innovation.

Panasonic Hollywood Lab

Optimized Pipeline Decoder Model

14th June 2003

3

Presentation Graphics Display Sets

- Presentation Graphics Display Sets:

1. **"Mode change"** Display Set:

PCS	CDS	ODS1	ODSn	END

complete set of OBJ definitions for PCS Page Instance

2. **"Acquisition point"** Display Set:

PCS	CDS	ODS1	ODSn	END

complete set of OBJ definitions for PCS Page Instance

3. **"Normal"** Display Set:

PCS	CDS	ODS1	ODSn	END

complete set of segments completely describing change from previous Display Set

mandatory
optional

Summary of Segment PTS/DTS Definition (1/3)

- PCS DTS:
  - Decoding time of PCS - instantaneously transfer PCS from Coded Data Buffer to Composition Buffer.
  - **This is a hint to the Decoder.**
  - **DTS may not be on the Frame Grid.**
- PCS PTS:
  - Presentation time of PCS i.e. all content described in the PCS must be available on the Graphics Plane at this time.
  - **This is an absolute time and must be followed by the Decoder.**
  - **PTS must be on the Frame Grid.**

5

Summary of Segment PTS/DTS Definition (2/3)

- ODS DTS:
  - Decoding time of ODS - instantaneously transfer ODS from Coded Data Buffer to Stream Graphics Processor (which instantaneously starts transfer to Image Buffer).
  - **This is a hint to the Decoder.**
  - **DTS may not be on the Frame Grid.**
- ODS PTS:
  - Presentation time of Object in Image Buffer i.e. the time when the Object is fully decoded and available in the Image Buffer
  - **This is a hint to the Decoder**
  - **PTS may not be on the Frame grid.**

Summary of Segment PTS/DTS Definition (3/3)

- CDS PTS/DTS:
  - Decoding time of CDS - instantaneously transfer CDS from Coded Data Buffer to Composition Buffer.
  - **This is a hint to the Decoder.**
  - **DTS may not be on the Frame Grid.**
- END PTS/DTS:
  - Decoding time of END - instantaneously transfer CDS from Coded Data Buffer to Composition Buffer.
  - **Marks the end of Decoding for a Display Set.**
  - **DTS may not be on the Frame Grid.**

7

Why before/later Object Reference? (1/4)

- Why do we want a PCS to reference Objects that will be decoded later as well as Objects that have already been decoded?
- Let's consider the following example:

Display Set 1: | PCS1 | ODS1 | ODS2 | END1 |

Display Set 2: | PCS2 | ODS3 | END2 |

PCS1 references ODS1 and ODS2.

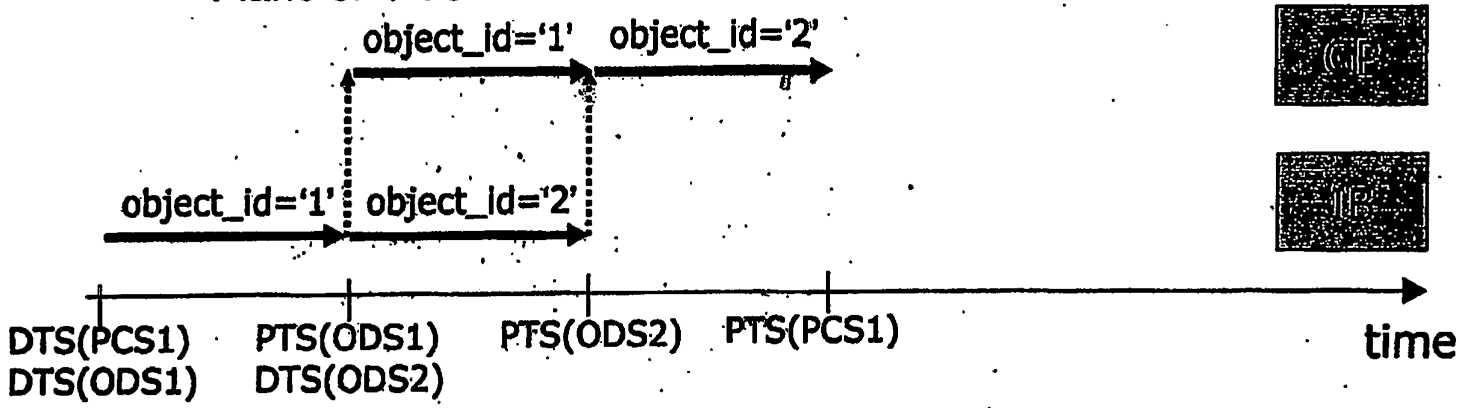
PCS2 references ODS2 and ODS3.

Only before Model: | ODS1 | ODS2 | PCS1 | ODS3 | PCS2 |

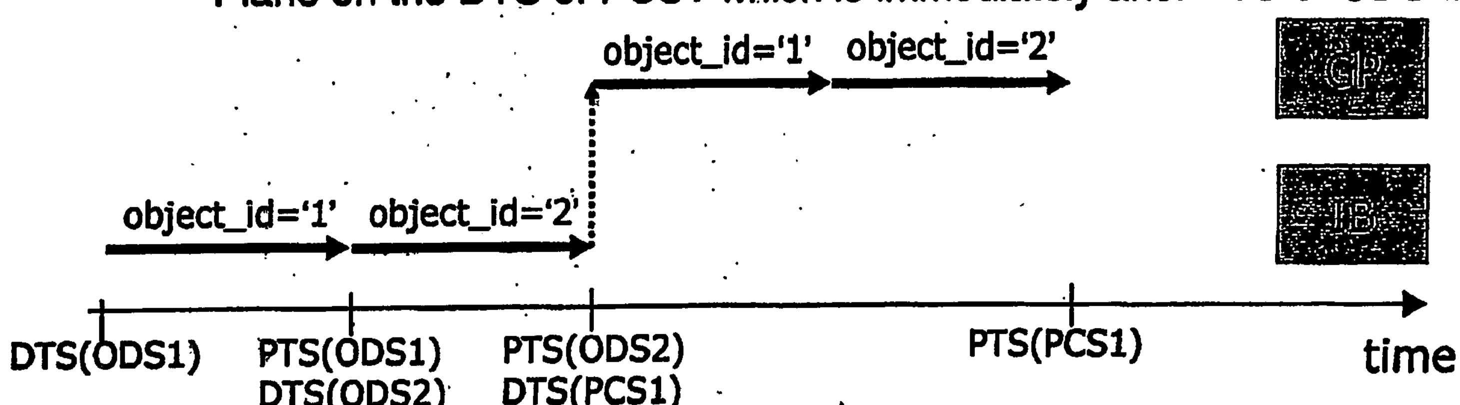
- When does composition transfer begin for each PCS?
  - Composition transfer means the transfer from the Image Buffer to the Graphics Plane.

Why before/later Object Reference? (2/4)

- PCS1:
  - Display Set Model: Object-1 can be transferred to the Graphics Plane on PTS of ODS1.



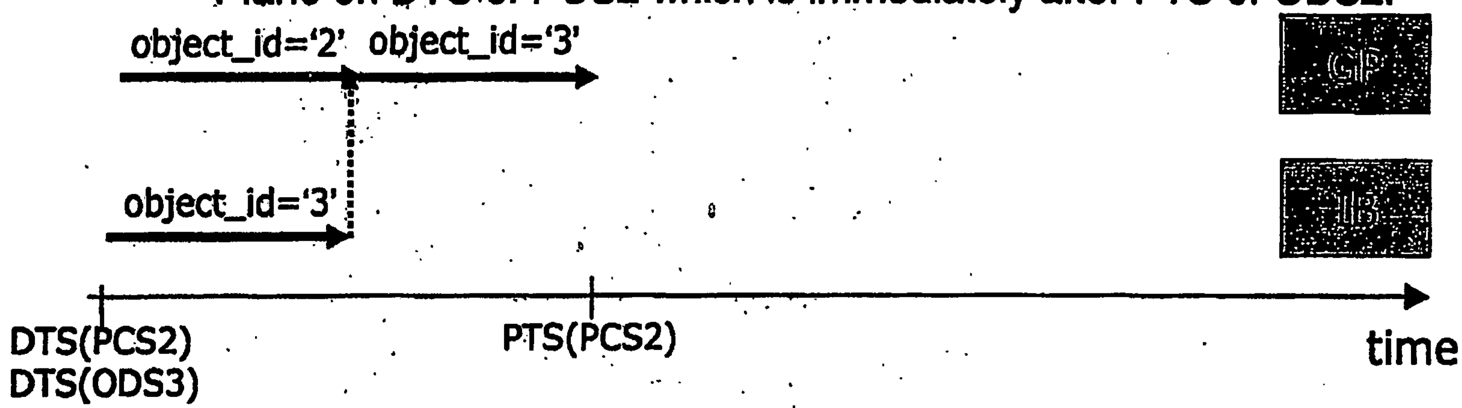
  - Only Before Model: Object-1 can be transferred to the Graphics Plane on the DTS of PCS1 which is immediately after PTS of ODS2.



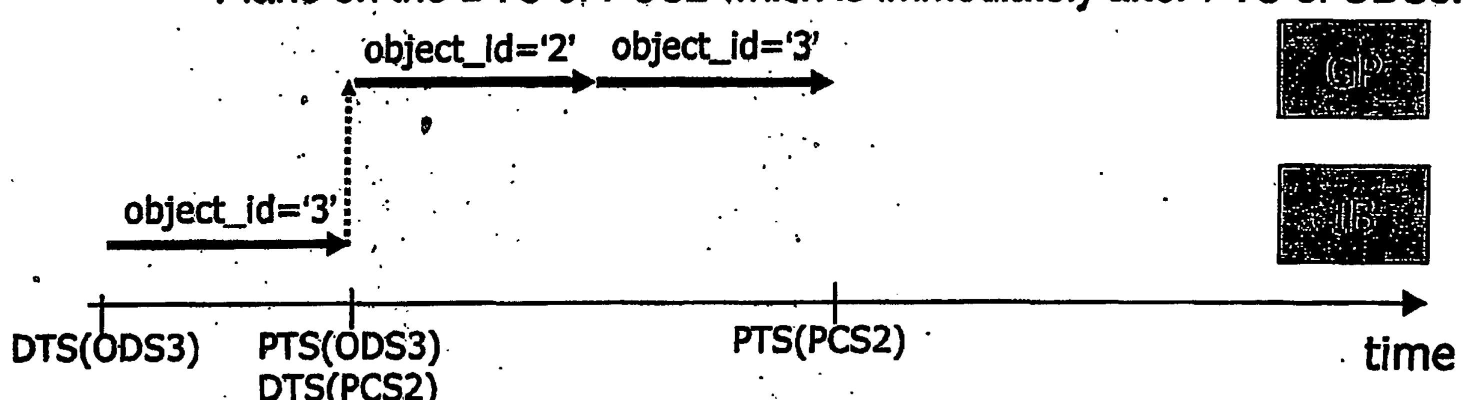
9

Why before/later Object Reference? (3/4)

- PCS2:
  - Display Set Model: Object-2 can be transferred to the Graphics Plane on DTS of PCS2 which is immediately after PTS of ODS2.



  - Only Before Model: Object-2 can be transferred to the Graphics Plane on the DTS of PCS2 which is immediately after PTS of ODS3.

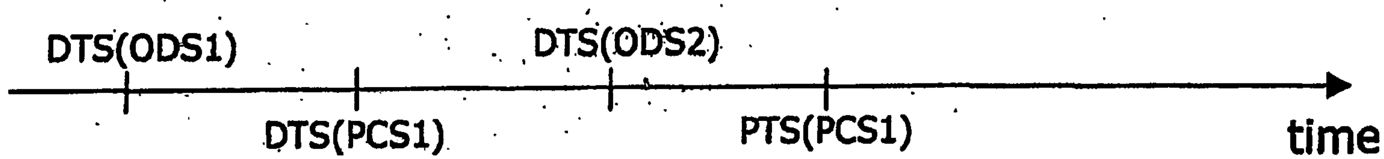


Why before/later Object Reference? (4/4)

- So, if we can reference Objects before and after a Composition Segment, decoding can be optimized.
  - Utilizes fact that Decoding and Composition are separate.
  - Considers that Object decoding is non-ideal model.
  - Remember – Segments cannot be removed from the Coded Data Buffer when an Object is being decoded.
- This is especially advantageous when considering an Epoch start and Acquisition Point – time to present data on-screen can be decreased.

Why Do we need "END"?

- Why do we need the Display Set structure, i.e. why do we need to use the "END" Segment?
  - END signals to the decoder that no more data is required to decode the Display Update.
  - We need END because a PCS can reference Objects that are still to be decoded.
- Let's consider the following example:



  - PCS1 references object_id='1'.
  - ODS1 carries object_id='1'.
  - ODS2 also carries object_id='1'.
  - Which object_id='1' is PCS1 supposed to reference?
- "END" frames each Display Update so it is easy to determine what objects a PCS references.

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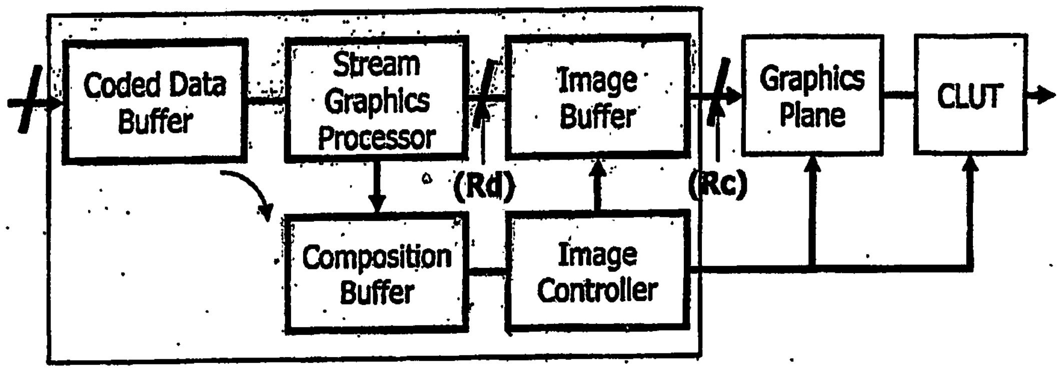
Decoder Model Image (1/4)

- Application Image:
  - Main Movie:
    - Representation of Dialog.
    - Localizations.
  - Extras:
    - Sing-a-long e.g. Children's titles, Karaoke-like.
    - "Creative" Additions to A/V Presentations e.g. Director's shadow, Highlight of area on motion picture image etc.
- To support these applications, the Decoder supports two types of animations:
  - Coded Animations.
  - Effect Animations:
    - cut-in/cut-out.
    - fade-in/fade-out.
    - color changes.
    - scrolling.
    - wipe-in/wipe-out.

Decoder Model Image (2/4)

- To overcome bandwidth problems, the Decoder has separated decoding from composition.

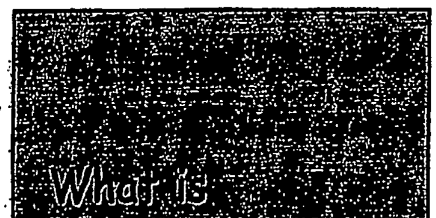


- Objects are decoded using a non-ideal model (Rd) and compositions are presented using a non-ideal model (Rc).
- Segments cannot be removed from the Coded Data Buffer whilst an Object is being decoded.

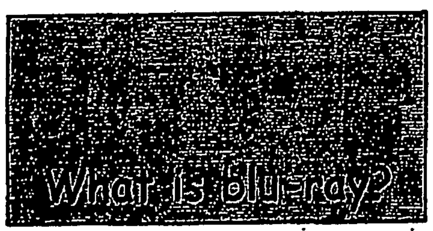
Decoder Model Image (3/4)

- Facilitator Opinion:
  - **We must support several decoded Compositions in the Composition Buffer in order to meet the Application image with the Decoding Model.**
  - **Achieved using DTS/PTS i.e. DTS is far ahead of PTS.**
  - **This allows the decoder to decode new Object Data whilst, at the same time, performing compositions on screen.**
- Consider the following simple example:

(1) new obj



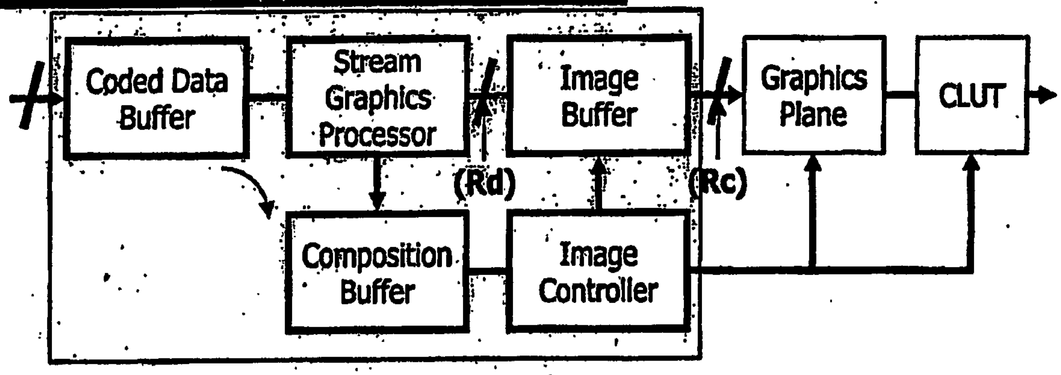
(2) effect (wipe)



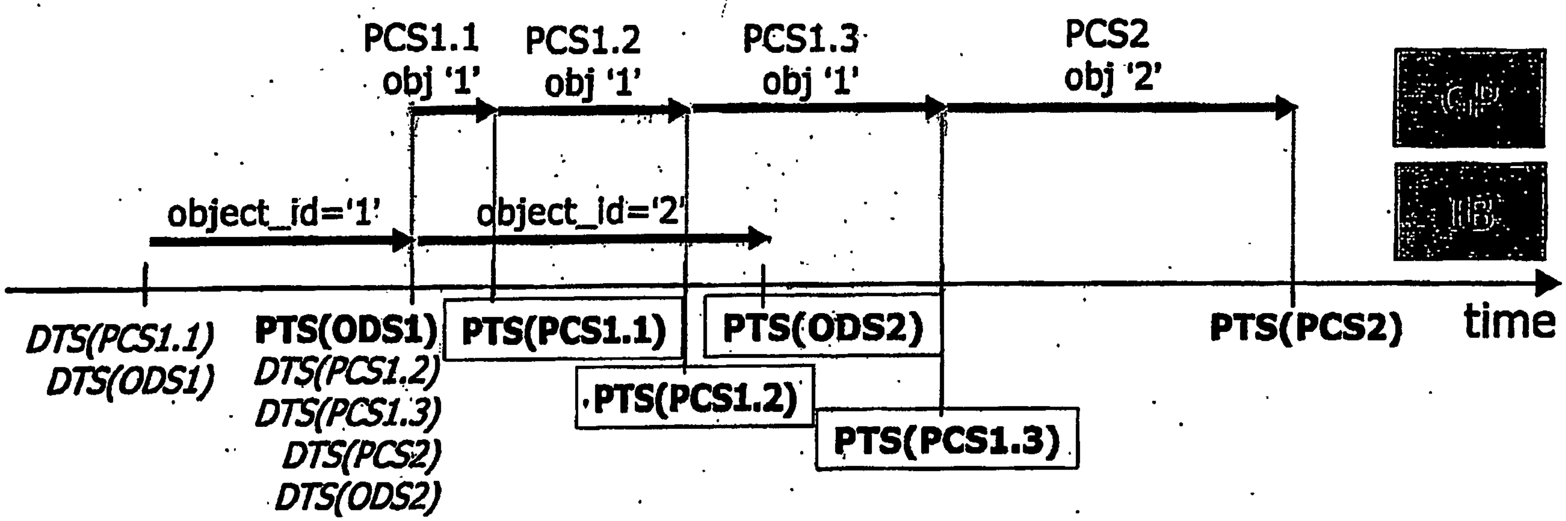
(3) effect (wipe)

(4) new obj

Decoder Model Image (4/4)



- Consider the following simple example:
  - (1) **PCS1.1-CLUT-ODS1-END (2) PCS1.2-END (3) PCS1.3-END**
  - (4) **PCS2-ODS2-END**



16

Graphics Display Rules (1/3)

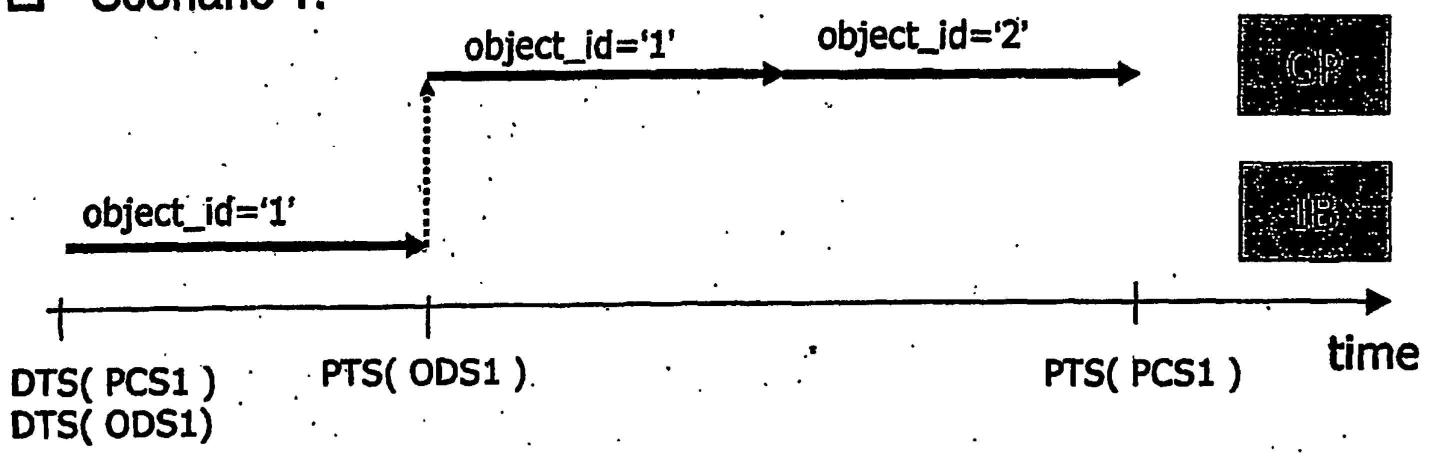
- We need to specify the behavior of displaying Objects so as to be able to verify the Graphics stream
  - We need to have an assumption of the order of data transfer from the Image Buffer to the Graphics Plane.
  - This assumption is required for calculating whether PTS value of the PCS is within constraints of the conceptual Decoder Model.
- Example:

PCS1	ODS1	ODS1	END1

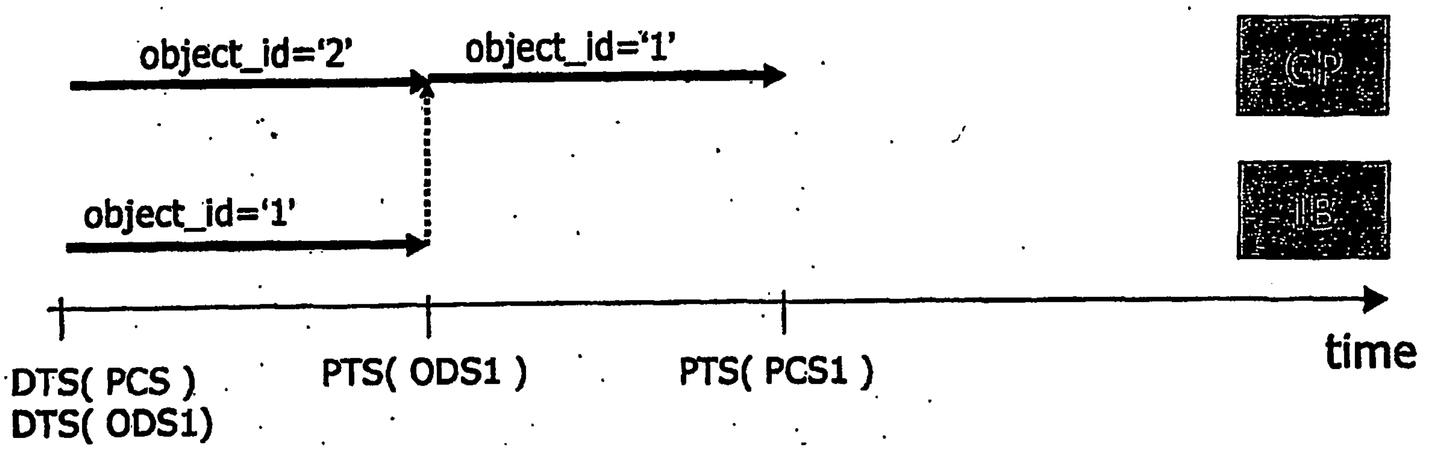
  - PCS1 references object_id='1' (contained in ODS1) and object_id='2' (previously decoded).
  - Scenario 1:
    - If object_id='1' is to be transferred to the Graphics Plane first then we must wait until it is decoded before this transfer begins.
  - Scenario 2:
    - If object_id='2' is to be transferred to the Graphics Plane first, then object_id='1' can be decoded in parallel with object_id='2' being transferred to the Graphics Plane.

Graphics Display Rules (2/3)

- Scenario 1:



- Scenario 2:



Graphics Display Rules (3/3)

- You can see that, despite the fact that the ODS PTS times remain constant, the PTS of the PCS can vary depending on the order that Objects are transferred to the Graphics Plane.
- Proposal:

1. **Objects are displayed in the order that they are defined in the PCS.**
2. **Use scanline order to premit support of on-the-fly hardware decoders.**

DTS/PTS Rules

1. **DTS(DS$n_{[I/PCS]}$) <= DTS(DS$n_{[CDS1]}$)**
   - The PTS of the first CDS in a Display Set shall be on or after the DTS of the ICS/PCS in the Display Set.

     DTS<=DTS

I/PCS	CDS1	CDS2	ODS1	END

   - DTS of CDS is represented by PTS of CDS.
2. **DTS(DS$n_{[CDSj]}$) <= DTS(DS$n_{[CDSj+1]}$)**
   - The PTS of a CDS shall occur on or after the PTS of the preceding CDS.

     DTS<=DTS

I/PCS	CDS1	CDS2	ODS1	END

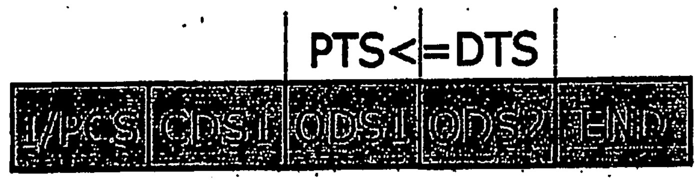
3. **DTS(DS$n_{[CDSlast]}$) <= DTS(DS$n_{[ODS1]}$)**
   - The DTS of the first ODS in a Display Set shall be on or after the PTS of the last CDS in the Display Set.

     DTS<=DTS

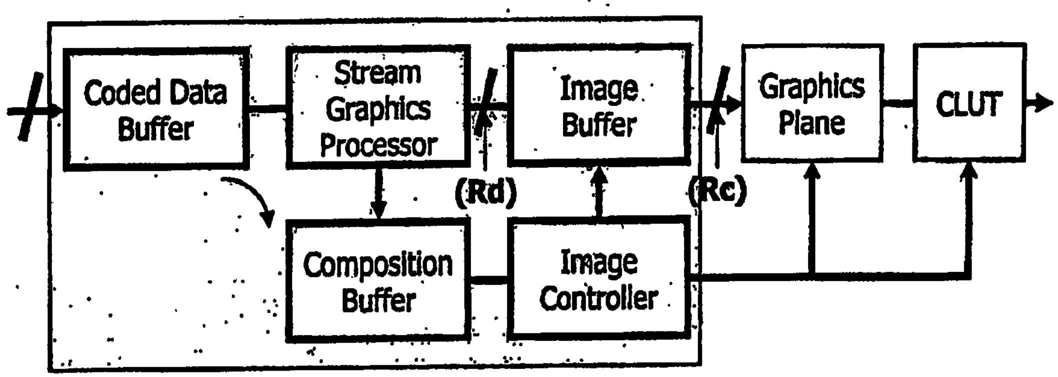
I/PCS	CDS1	CDS2	ODS1	END

DTS/PTS Rules

4. **PTS(DS$n_{[ODSj]}$) <= DTS(DS$n_{[ODSj+1]}$)**
   - ☐ The DTS of an ODS shall occur on or after the PTS of the preceding ODS.
   - ☐ *The DTS of an ODS must occur when there is no transfer from the Stream Graphics Processor to the Image Buffer.*

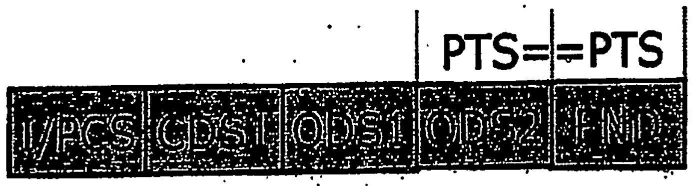


5. **PTS(DS$n_{[ODSj]}$) == DTS(DS$n_{[ODSj]}$) + OBJ(DS$n_{[ODSj]}$) / Rd**
   - ☐ The PTS of an ODS shall occur when the Object has been fully decoded to the Image Buffer.

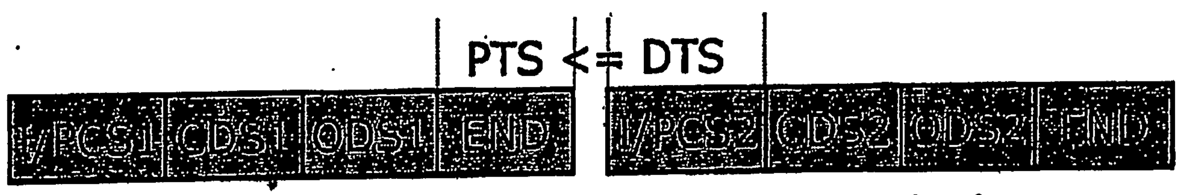


DTS/PTS Rules

6. **PTS(DS$n_{[END]}$) == PTS(DS$n_{[ODSlast]}$)**
   - The PTS of an END shall occur on the PTS of the last ODS.
   - *The PTS of an END shall occur at the end of the decoding of the Display Set.*



7. **PTS(DS$n_{[END]}$) <= DTS(DS$n+1_{[I/PCS]}$)**
   - The DTS value of the first Segment in a Display Set shall occur on or after the PTS of the END Segment in the immediately previous Display Set.
   - *The DTS value of the first Segment in a Display Set shall occur after all ODSs from the preceding Display Set have been decoded.*



Display Set 1 Display Set 2

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DTS/PTS Rules

8. $PTS(DSn_{[PCS]}) >= DTS(DSn_{[PCS]}) + \sum_{I=0}^{I<PCS.num\_objects} DURATION(DSn_{[PCS]}.[OBJ_{[i]}])$

- The PTS of a PCS shall occur after the DTS of the PCS plus the duration to transfer all Objects referenced in the PCS from the Image Buffer to the Graphics Plane plus any additional time for transfer from the Coded Data Buffer to the Image Buffer.
- *There must be enough time to transfer the Objects required for a composition from the Image Buffer to the Graphics Plane.*

23

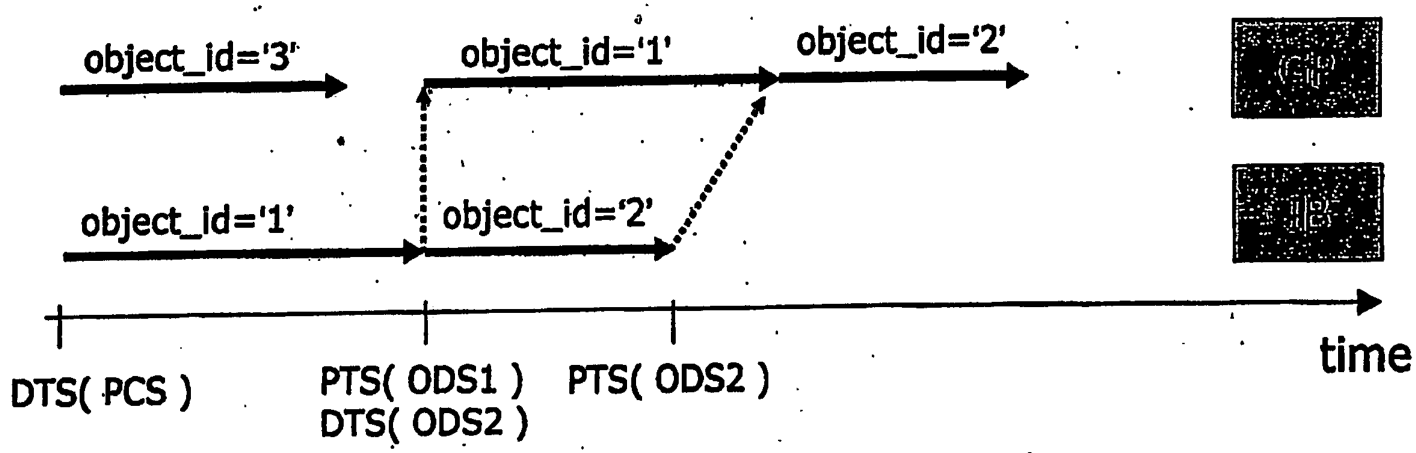
DTS/PTS Rules

8. **Example:**

- We have the following Display Set:

PCS1	ODS1	ODS1	ODS2	END1

- PCS1 references the Object contained in ODS1 (object_id='1') and ODS2 (object_id="2") and a previously decoded object (object_id='3').
- PCS object reference order is '3','1','2'.



DTS/PTS Rules

8. $$PTS(DSn_{[PCS]}) >= DTS(DSn_{[PCS]}) + \sum_{I=0}^{I<PCS.num\_objects} DURATION(DSn_{[PCS]}.[OBJ_{[i]}])$$

Where $\sum_{I=0}^{I<PCS.num\_objects} DURATION(DSn_{[PCS]}[OBJ_{[i]}])$ is given by the following:

```
decode_duration = 0;
for( i=0; i < DSn.PCS.num_of_objects; i++ )
{
    if( EXISTS(DSn.PCS.OBJ[i].object_id, DSn )
    {
        object_time = PTS( GET(DSn.PCS.OBJ[i].object_id) );
        current_time = DTS( DSn.PCS ) + decode_duration;
        if( current_time < object_time )
            decode_duration += object_time - current_time;
    }
    decode_duration += SIZE( DSn.PCS.OBJ[i] )/Rc;
}
```

DTS/PTS Rules

9. $PTS(\ DSn{+}1_{[PCS]}\ ) >= PTS(\ DSn_{[PCS]}\ ) +$

$$\sum_{i=0}^{i<PCS.num\_objects} SIZE(\ DSn{+}1_{[PCS]}.[OBJ_{[i]}]\ )\ /\ Rc\ )$$

- ☐ The PTS of a PCS shall occur after the PTS of the immediately previous PCS plus the time taken to transfer all Objects referenced in the PCS from the Image Buffer to the Graphics Plane.
- ☐ *There must be enough time to transfer the Objects required for a composition from the Image Buffer to the Graphics Plane after the previous composition.*

26

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